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Recording medium

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GB A 2012617
GB 0540148

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B2E

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FIG. 1

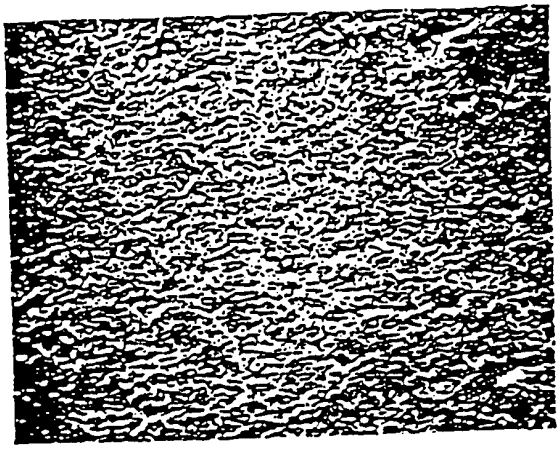
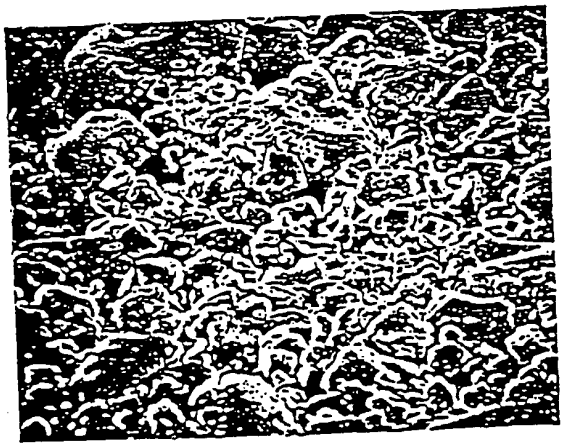


FIG. 2



RECORDING MEDIUM

This invention relates to a recording medium such as recording paper particularly but not exclusively suitable for use in ink-jet recording or ink-transfer type thermal recording, and more particularly to a recording medium for such purposes which is excellent in ink absorptivity and coloration of image.

Attention is directed to Applications Nos. 85/20224 and 85/20225 which are divided from this application.

Methods of recording by use of recording liquids involve, for instance, an old and general method: writing with a fountain pen or the like, and a recently developed method: so-called ink-jet recording. The ink-jet recording system is a recording method in which droplets or recording liquid are generated and flown by one of various operation principles and attached onto a recording medium such as paper or the like to form images. Ink-jet recording is noticed in that it generates less noises and permits high speed printing and multicolor printing. Water-based recording liquids are predominantly used for ink-jet recording in aspects of safety and printability.

For ink-jet recording, usual paper has so far been used in general as recording medium. However,

requests for the medium are growing more severe with improvements in the performance of ink-jet recorders, such as developments of higher speed recorders and multicolor recorders. That is, for securing high degree of resolution and high quality of images, the ink-jet recording medium is required to fulfill the following requirements:

(1) It should absorb ink as quickly as possible.

(2) When ink dots overlap one another on the medium, the later ink should not run on the earlier ink dot.

(3) Diameters of ink dots on the medium should not be enlarged more than necessary.

(4) Shapes of ink dots on the medium should be close to a right circle and the outlines thereof should be smooth.

(5) Ink dots on the medium should have high optical density and the outlines thereof should not be obscure.

Further, the recording medium for multicolor ink-jet recording is requested to fulfill the following requirements, in addition to the above, in order to achieve image quality comparable to that of color photographs:

(6) It should have a high brightness.

(7) Ink dots of different colors on the medium should exhibit each a good coloration.

(8) Ink absorptivity of the medium should be

particularly superior since ink dots of different colors may often overlap one another.

The ink-transfer type thermal recording system has been developed lately, wherein wax-containing colorants (solid inks) are utilized. The recording medium for this recording system also is required to fulfill the above requirements. In particular, it is required when ink dots overlap one another that the formerly dotted ink shall not be molten to diffuse with the heat applied for the next dotting or with the heat contained in the next dotted ink.

However, it is the present situation of the art that any recording medium satisfying all the above requirements is not yet found. As an example, the ink-jet recording paper described in Japanese Pat. Laid-open No.74304/1977 quickly absorbs ink, but has disadvantages in that ink dots on the paper are liable to be enlarged in diameter and hence the outlines thereof becomes obscure, and that a dimentional stability of the paper is poor after recording.

The primary object of this invention is to provide a full-color-recording medium which satisfies such various requirements as noted above, particularly has high absorptivity for ink and gives images of good coloratiions.

According to the invention there is provided a recording medium particularly but not exclusively suitable for use in ink-jet recording or ink-transfer type thermal recording which comprises a substrate and an ink receiving layer on said substrate, wherein the Bekk smoothness of the ink receiving layer surface is from 20 to 120 seconds.

Preferably the Bekk smoothness of said ink receiving layer surface is from 28 to 108 seconds.

Preferably said ink receiving layer comprises a filler and binder, the irregular shapes of said filler appearing at the surface of said ink receiving layer.

In the drawings:

Fig. 1 is a scanning electron microscopic photograph of magnification factor about 1500 showing a face of a commercially available art paper. Fig. 2 is a scanning electron microscopic photograph of the same magnification factor showing a face of the coating layer of the recording medium prepared in Example 1 of this invention.

The recording medium of this invention is characterized by the unique surface state of its ink receiving or coating layer which acts as an ink acceptor. That is, the Bekk smoothness of the coating layer ranges from 20 to 120 seconds. Preferably the average value of maximum heights at 10 points selected at random on the surface of the coating layer, as determined in accordance with the JIS B-0601 method of measuring surface roughness, ranges from 10 to 35 μ for a referance length of 2.5 mm.

The coating layer preferably has a surface structure such that the filler particles of irregular shapes and relatively large particle sizes, which are the main component of the coating layer, appear at the surface of the coating layer in the state of random distribution. And numerous large interstices, which act as ink absorbing pores, exist among the filler particles. A typical surface state of the coating layer is shown in Fig. 2. These particles of the filler are of course fixed with the binder within the coating layer and therefore do not readily separate therefrom. The surface state, like scattered tile fragments of various sizes, is well shown by Fig. 2.

Fig. 1 is a similar photograph of a coating layer face of a conventional recording medium. This coating

layer has a flat surface structure, while numerous fine pores serving as recording liquid absorbers are present in the layer.

As stated above, the preferred recording medium of this invention has numerous large interstices serving as ink absorbers among filler particles, so that the ink attached onto the medium surface are quickly absorbed into these interstices and also the ink absorption capacity of the medium is great.

When the Bekk smoothness of the coating layer is less than 20 seconds, the ink absorptivity may be insufficient. On the other hand, when the value exceeds 120 seconds, the degree of resolution of the printed image lowers though the ink absorptivity is satisfactory.

While paper is usually the most suitable substrate of the recording medium of this invention, other substrates can also be used including porous materials such as cloth, synthetic paper, porous resins, and wood, and non-porous materials such as non-porous resins, metals, and glass. The choice of the substrate from these materials depends upon the purpose and use of recording.

The coating layer of the recording medium of this invention preferably includes a filler and a binder. Suitable materials for the filler are white inorganic pigments including, for example, silica, clay, talc, diatomaceous earth, calcium carbonate, calcium sulfate, barium sulfate, titanium oxide, zinc oxide, satin white, aluminum silicate, lithopone, alumina, and zeolite; and organic powdery materials including, for example, ion exchange resin powders and plastic pigments. These fillers can also be used in mixture. Among these fillers, porous inorganic pigments are particularly preferred.

For the purpose of forming the coating surface where filler particles irregular in shape are distributed at random like scattered tile fragments, particle sizes of the filler used are desired to range approximately from 1 to 30 μ, preferably from 3 to 20 μ. Too large particle sizes of the filler are undesirable, since the circularity of ink dots is deteriorated and the resolution degree of images is lowered, on the resulting recording medium. Filler particles of higher absorptivity for coloring matter and those having a porous structure are preferable. It is because the coloration is best when coloring matter in the ink applied to the recording medium is captured at outermost

sites in the coating layer of the recording medium.

Binders for use in the coating layer include; water-soluble macromolecular compounds, for example, starch, gelatin, casein, gum arabic, sodium alginate, carboxymethyl cellulose, poly(vinyl alcohol), polyvinyl pyrrolidone, sodium polyacrylate, and polyacrylamide; synthetic rubber latexes; and organic-solvent-soluble resins, for example, poly(vinyl butyral), poly(vinyl chloride), poly(vinyl acetate), polyacrylonitrile, poly(methyl methacrylate), poly(vinyl formal), melamine resin, polyamide resins, phenolic resins, polyurethane resins, and alkyd resins. If necessary, these polymers can be used in combination. Some of various additives such as a dispersing agent, optical brightener, pH regulator, defoaming agent, lubricant, and preservative, surfactant, can also be incorporated into the coating layer.

The recording medium of this invention can be prepared by coating a substrate with a dispersion of the above-mentioned components of the coating layer in water by the roll coating, rod bar coating, spray coating, and air knife coating method and drying the coat as quickly as possible. Suitable compounding ratios of the binder to the filler are 10 : 100 -100 : 100 by weight. When the

filler has a relatively large average particle size, better results are obtained by minimizing the amount of binder. Suitable amounts of the coating layer on the substrate are usually about 1 - about 50 g/m^2, preferably about 2 - about 30 g/m^2, in dry coating weight.

The recording medium of this invention, having a coating layer of a unique surface structure on a substrate, exhibits very high ink absorptivity; even when ink dots of the different color overlap one another in a short time, the phenomenon of elusion or bleeding of dotted ink does not occur on the recording medium, so that distinct images with a high degree of resolution are obtained. Additionally the images on the recording medium are excellent in coloration. Thus, the present recording medium is best suited for full-color ink-jet recording.

This invention is illustrated in more detail referring to the following Examples: In the Examples "parts" are all by weight.

Comparative Example 1

A commercial art paper (tradename: SK Coat, mfd. by Sanyo-Kokusaku Pulp Co., Ltd.) was evaluated as a

recording medium for ink-jet recording characteristics. Results of the evaluation are shown in Table 1. Fig. 1 is a scanning electron microscopic photograph of magnification factor ca. 1500 showing a face of the coating layer of this paper.

Example 1

A coating composition was prepared according to the following formulation:

Formulation

Silica (tradename: Syloid 404, average particle size 10 μ, mfd. by Fuji-Davison Chem. Co., Ltd.) as filler	100 parts
Calcium carbonate (average particle size 2 μ) as filler	15 parts
Poly(vinyl alcohol) as binder	30 parts
SBR latex as binder	3 parts
Water	500 parts

Then, the same common wood-free paper as used in Example 2 was coated with the above composition by means of a blade coater so as to give a dry coating weight of 10 g/m^2 and was dried in the usual way, whereby a recording medium was obtained. Fig. 2 is a scanning electron microscopic photography of magnification factor ca. 1500 showing a face of the coating layer of the recording medium.

Results of evaluating recording characteristics and the Bekk smoothness of this recording medium are shown in Table 1. The Bekk smoothness was measured by using an Ohken's air permeability - smoothness tester (supplied by Asahi Seiko Co., Ltd.)

Example 2

A coating composition was prepared according to the following formulation:

Formulation

Diatomaceous earth
(tradename: Celite 281, average
particle size 8 μ, mfd. by
John-Manville Co.) as porous

inorganic pigment	100 parts
Starch as binder	30 parts
SBR latex as binder	10 parts
Water	800 parts

Common wood-free paper (basis weight 65 g/m^2) having a size degree of 35 seconds as measured in accordance with JIS P-8122 was coated with the above composition by means of a blade coater so as to give a dry coating weight of 10 g/m^2 and was dried in the usual way, whereby a recording medium was obtained.

The recording medium was evaluated in the same manner as in Example 1. The results are shown in Table 1.

Example 3

A coating composition was prepared according to the following formulation:

Formulation

Zeolite (average particle size 10 μ) as filler	100 parts
Talc (average particle size 7 μ) as filler	10 parts
Casein as binder	20 parts
Water	500 parts

Then, the same common wood-free paper as used in Example 2 was coated with the above composition by means of a bar coater so as to give a dry coating weight of 15 g/m^2 and was dried in the usual way, whereby a recording medium was obtained.

Results of evaluating this recording medium in the same manner as in Example 1 are shown in Table 1.

Comparative Example 2

The same commercial art paper as of Comparative Example 1 was evaluated as a recording medium in the same manner as in Example 1. The results are shown in Table 1.

Comparative Example 3

Using calcium carbonate (average particle size 50 μ) as filler and poly(vinyl alcohol) as binder, a coating composition was prepared according to the following formulation:

Calcium carbonate (average particle size 50 μ) as filler	100 parts
Poly(vinyl alcohol) as binder	5 parts
Water	50 parts

Then, the same common wood-free paper as used in Example 2 was coated with the above composition by means of a bar coater so as to give a dry coating weight of 15 g/m^2 and was dried in the usual way, whereby a recording medium was obtained.

Results of evaluating this recording medium in the same manner as in Example 1 are shown in Table 1.

In Table 1, the items and criteria of evaluation are as follows:

(1) The optical density of ink dot was measured by using Micro-Densitomer PDM-5 (supplied by Konishiroku Photographic Ind. Co., Ltd.).

(2) The shape of ink dot was observed with a stereo-microscope. A nearly circular shape was marked with o, slightly deformed circular shape with Δ, and irregular shape with x.

(3) The blotting degree (spread degree) of ink dot was represented by the ratio of the diameter of ink dot measured with a stereo-microscope to that of the original ink droplet.

(4) The brightness of color was evaluated by visual observation of the image formed by ink-jet recording. It was ranked with ⓞ, o, Δ, or x in order of from good to bad.

(5) The ink absorptivity was evaluated by applying four ink droplets of different colors to overlap one another and observing the state of the ink dots. When the diffusion or bleeding of inks was not observed and the image was distinct, the sample was marked with o. In other cases, the sample was marked with x.

TABLE 1

Item (color of used ink)	Example 1	Example 2	Example 3	Comparative Example 2	Comparative Example 3
Bekk smoothness (sec.)	108	28	60	1200	10
Optical density of ink dot (Black)	0.78	0.74	0.74	0.35	0.68
Shape of ink dot (Black)	o	o	o	o	x
Blotting degree of ink dot (Black)	2.5	2.6	2.6	3.5	2.8
Brightness of color (Yellow)	◎	o	o	x	o
" (Red)	◎	o	Δ	x	◎
" (Blue)	◎	o	o	x	◎
Ink absorptivity (Black)	◎	o	o	x	x

Syloid, ~~Telysurf,~~ and Celite are registered Trade Marks.

CLAIMS:

1. A recording medium particularly but not exclusively suitable for use in ink-jet recording of ink-transfer type thermal recording which comprises a substrate and an ink receiving layer on said substrate, wherein the Bekk smoothness of said ink receiving layer surface is from 20 to 120 seconds.

2. A recording medium according to claim 1 wherein the Bekk smoothness of said ink receiving layer surface is from 28 to 108 seconds.

3. A recording medium according to claim 1 or claim 2 wherein said ink receiving layer comprises a filler and binder, the irregular shapes of said filler appearing at the surface of said ink receiving layer.

4. A recording medium according to claim 3 wherein said filler is a porous inorganic pigment.

5. A recording medium according to any of claims 2, 3 or 4 wherein particle sizes of said filler range from 1 to 30 μm.

6. A recording medium according to any preceding claim wherein said ink receiving layer has a porous structure.

7. A recording medium substantially as described herein with reference to any one of the Examples.

8. A method of ink jet printing utilising a recording medium according to any preceding claim.